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NON-SEGMENTATION, INDIVIDUAL PIXEL-BY-PIXEL-BASED IMAGE RENDERING SYSTEM

FIELD OF THE INVENTION

The present invention relates generally to digital imaging and, more particularly, to a non-segmentation system and related methodology for rendering an image to a printer or other image output device for producing images made up of a large plurality of pixels.

BACKGROUND

Ongoing improvements in personal computers allow users to prepare documents of increasing complexity and variety. Printer manufacturers are increasingly challenged to develop printing systems capable of printing high-quality, high-resolution heterogeneous documents. As the term is used herein, heterogeneous documents are documents that include more than one of the following: images, graphics, and text. Ideally, heterogeneous documents printed by printers accurately reproduce what is composed on a high-resolution computer monitor.

As an example of one of the challenges facing the printing industry, computer monitors are based on a color regime of red, green and blue pixels (RGB), whereas color printers, namely, inkjet printers, are typically based on a color regime of cyan, magenta, yellow and black (CMYK). The RGB color components of computer monitors are combined together in an "additive" way by mixing red, green and blue light rays to form a plurality of different displayable colors. In contrast, the CMYK components of color inks are applied to media in different combinations in a "subtractive" way to form a plurality of printable colors consistent with CMYK ink cartridges typically contained within the inkjet printer. Transforming images from "RGB space" to "CMYK space" necessary for printing the image on an inkjet printer requires the use of color-rendering techniques.

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One color-rendering technique is halftoning. A halftoning algorithm is a process of transforming a continuous-tone image into a binary image that gives the illusion of the original continuous-tone image. Use of a single halftoning algorithm, when rendering a document, works well when the content of the document to be printed is homogeneous. For example, if the content of the document to be printed consists of only text, or only graphics, etc., an algorithm could be selected that will optimally render the text or graphics to the printer. In contrast, when a document is heterogeneous, containing various mixtures of text, graphics, or images, prior art single halftoning processes do not work as well because a given halftoning algorithm is directed to optimal rendering of only a single type of image.

Prior-art image rendering systems have attempted to address this problem. For example, U.S. Patents ~~numbers~~ Numbers 5,327,265 and 5,272,549 attempted to address the aforementioned problem by using a method wherein both text and images are printed separately, but in the same document. These methods include combining inkjet and laser printer components in a printing system in which the printed information is divided into color and text. The color images are printed using the inkjet printer component and the text (or non-color material) is printed by the laser printer component. This approach has the disadvantage of requiring very complex printers in order to print heterogeneous documents.

U.S. Patents ~~numbers~~ Numbers 5,704,021 and 6,040,927 disclose methods of color inkjet printing for use in printing documents having different color object types. Based on the identified color object type, selected color rendering options are used by the color inkjet printer to produce the document. The prior-art systems in the '021 and '927 patents require categorizing areas of a heterogeneous document to be printed, based on the type of objects contained in regions of the document, and then rendering the objects accordingly.

It would be advantageous to have an image rendering system capable of[:] (1) improving print quality of heterogeneous images, (2) increasing the, speed at

which heterogeneous images are rendered to a printer and, (3) rendering high quality heterogeneous images to relatively inexpensive conventional printers such as inkjet printers without being limited by object type.

SUMMARY OF THE INVENTION

The present invention provides a non-segmentation, individual pixel-by-pixel-based image rendering system and method of processing source image data for instructing an output device in providing an image having a plurality of pixels. Each pixel has a predetermined number of data bits that are processed by coupling image information to each pixel, assessing the image information for each pixel, and rendering each pixel of the image according to the image information coupled to each pixel.

The invention further provides a pixel based image rendering system for instructing a printer in providing an image having a plurality of pixel data sets. The image rendering system includes a data storage device for temporarily is storing the pixel data sets of the image and a software means for associating one or more image information bits to each pixel data set in the data storage device. Additionally, the image rendering system contains a print processing means responsive to the pixel data sets and the image information bits. The image information bits are associated with each pixel data set for rendering the pixels of the image using an image rendering process selected by the image information associated with each pixel data set.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic illustration of a prior art printing system used to generate and print documents or images.

Figure 2 is a schematic representation of an image rendering system for pixel based image rendering in accordance with the present invention.

Figure 3(a) is a pictorial representation of a pixel data set of the type used as source image data (prior art).

operatively connected directly to the print driver 18 of computer 12, as illustrated schematically in Figure 1 by dashed line 27. In the description of the present invention provided below, it will be understood by those skilled in the art that a printer shown connected to a print driver may, alternatively, within the scope of the present invention, be connected via a suitable network or via direct connection.

Memory allocation block 14 of computer 12 supports application software, such as word processors, spreadsheets, and database rendering systems. Additionally, computer-aided design and imaging software, such as AutoCAD and PhotoShop, respectively, are supported by memory allocation block 14. The various software applications may be used to generate homogeneous or heterogeneous images consisting of a multiplicity of pixels. When the pixels of the homogeneous or heterogeneous images are to be printed, they form an image data stream 24 as they pass through computer 12 in route to printer 22.

GDI 16 of computer 12 is used by most Windows applications to display images on a monitor. The GDI is instrumental when printing from a Windows application to a printer because the data (including image data stream 24) generated by the program does not need to be converted to printer controller language, for example, PostScript (Trademark). Hence, the user can print a homogeneous or heterogeneous image, viewable on a computer's monitor, directly to a printer, or indirectly to a printer through printing network 20, via print driver 18. Print driver 18 converts the application data received from GDI 14 to image data printable on printer 22.

Figure 2 is a schematic representation of one embodiment of the non-segmentation, individual pixel-by-pixel Image Rendering System (IRS) 26 employing an illustrative embodiment of the present invention and implementing the methodology of this invention. For the purpose of the present invention, IRS 26 refers to a digital imaging process for converting image data in its original form, as it emerges from an image source such as a GDI, to another form suitable for printing on a binary printer such as, for example, an inkjet printer. IRS 26 ~~employes~~ employs image

rendering processes including halftoning processes and color rendering algorithms. IRS 26 includes GDI 16, and an IRS print driver 19. IRS print driver 19 further includes an interim data storage block 28, a coupled image information block 30, and a document rendering block 32.

A heterogeneous image 34 created by a software application may contain any combined multiplicity of monochrome or color text pixels, monochrome or color image pixels, monochrome or color graphics pixels, or white pixels. A homogeneous image, in contrast, is composed of only one pixel type. A homogeneous or heterogeneous image is alternatively referred to herein as a homogeneous or heterogeneous document.

GDI 16 operates on the source image pixels and outputs the pixels as an image data stream 24 to interim data storage block 28 within IRS print driver 19. Blocks 28, 30, and 32 illustrate process steps carried out in IRS print driver 19. Within IRS print driver 19, pixel data, which is temporarily stored in interim storage 28, is coupled to image information, such as information identifying the pixel type, in step 30. Attaching image information may sometimes be referred to herein as 'adding' image information to each pixel. Adding, for the purpose of this invention, means associating or coupling image information to each pixel. The attached image information is associated with one of four different pixel types, as will be described in greater detail below. The modified pixel information 36 is then rendered in block 32. IRS print driver 19 renders images in accordance with the present invention using attached image information, as will be described in below.

Printer 22, for example, an inkjet printer, then prints a hard copy 38 of heterogeneous image 34. One skilled in the art will recognize that although IRS 26 is coupled to only one printer, IRS print driver 19 could be used to render a heterogeneous or homogeneous image to a plurality of printers through a printing network as illustrated in Figure 1.

image halftoning. In contrast, if second image information bit 55 of image information 54 is a "1", pixel 40 is channeled to rendering section 75 where pixel 40 is color converted and subsequently halftoned using a halftoning process specifically designed and optimized for a text/edge pixel.

Next, consider second bit assessment block 66. If second image information bit 55 of image information 54 is a "1" pixel 40 is channeled to rendering section 80 where pixel 40 undergoes TRC adjustment and is subsequently halftoned using a halftoning process specifically designed and optimized for a monochrome pixel. In contrast, if the second image information bit 55 of image information 54 is a "0", (see second bit assessment block 66) pixel 40 is channeled to pixel rendering section 85 where pixel 40 does not undergo a halftoning process, hence the halftoning process is avoided.

The location of IRS print driver 19 in IRS 26 shown in Figure 2 is flexible as illustrated in Figure 5(a), 5(b), and 5(c), collectively Figure 5. Figure 5(a) shows a preferred embodiment wherein the IRS 26 of the invention is disposed in a computer 12. The IRS 26 of the present invention could, however, be disposed in a printer 68, as shown in Figure 5(b). Disposing the invention in printer 68 may be accomplished through implementing the process described in Figure 4 within the printer's firmware or hardware (e.g., application specific integrated circuits). Another embodiment of the invention is shown in Figure 5(c). Here, IRS 26 of the invention is disposed in a printer controller 90 located external to computer 12 and printer 22.

From the detailed description, it will be appreciated that the present invention provides a non-segmentation, individual pixel-by-pixel-based image rendering system having several objects and advantages including but not limited to the following: (1) The quality of the printed images is improved because each pixel of a homogeneous or heterogeneous image is rendered individually according to image information attached to each pixel; (2) The speed at which an image is printed is increased because some selected pixels are not rendered; and (3) heterogeneous images can